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# Birds, Beasts, and Bugs

*E. R. Kalmbach*

Birds, mammals, and other vertebrates work constantly toward the natural suppression of insects. They may not always effect complete control, but they exert a steady and at times an emphatic local effect on insect populations. Farmers particularly do well to appreciate the help that birds give them.

Circumstances of the times led early research in economic ornithology and mammalogy into qualitative rather than quantitative channels. Most of the problems were approached with the idea of disclosing through stomach analysis the character of the food of birds and mammals; through a process of deduction an appraisal was made of the economic status of the creature involved. By far the greater part of our knowledge still is of this character, but keen observers through the years have encountered and appraised in the field instances of insect suppression that have been recorded quantitatively. Usually these recitals deal with local or temporary conditions, yet their frequency of occurrence under many diversified conditions gives indication of the possibilities.

To present this information one must resort to a compilation of published reports and in doing so I avail myself to a large extent of the contributions of W. L. McAtee, who more than anyone else has assembled information of this kind and whose philosophies with respect to bird-insect relations are classical.

McAtee always took pains to preface his dissertations on avian economics with words of caution regarding the nature and extent of benefits to be expected, as for instance:

"The general utility of birds in checking the increase of injurious animals and plants is well understood. It must be admitted, however, that while birds constantly exert a repressive influence on the numbers of the organisms they prey upon and even exterminate certain pests locally, they are not numerous enough to cope successfully with widespread invasions.

"Birds are prone to feed upon things that are abundant and easily accessible, for instance, in elderberry season a very large number of birds take elderberries; if May-flies swarm in a locality, practically all of the birds there devour May-flies. Thus, under unusual conditions, such as attend outbreaks of insects or other pests, birds may very naturally turn their attention to the plentiful and easily obtained food, and the attack on a particular pest often is intensified also by the flocking of birds from surrounding areas."

THE INSTANCES of insect suppression that I recite here are mere fragments from an abundant literature. I make no attempt to include illustrations even from all the major groups of insects or all the species of birds whose good work is on record.

Plagues of grasshoppers (locusts) have been recorded throughout the history of mankind. In our country one frequently encounters a recital of what was considered providential aid rendered by gulls in the control of the Mormon cricket in the early days of settlement in the Salt Lake Valley. Less heralded but no less significant have been the instances of grasshopper suppression by birds in the Midwest. An example was reported by Samuel Aughey in Nebraska.

He stated: "No Nebraskan will forget the countless number of young locusts that hatched out in the spring of 1875. Only where they were removed by causes known or unknown were crops produced during this season over the infested region. Among the few causes operating in the destruction of locusts during that period was the work of insectivorous birds. Among the spots that birds frequented was one on the west side of Salt Creek, not more than 2 miles from Lincoln. There was a small area of about 320 acres that harbored an immense number of locusts. The birds, however, made it one of their feeding grounds, and the locusts lessened daily in numbers. Within a month hardly a locust was left. Similar instances of the work of birds were observed farther down on Salt Creek and on Middle Creek.

"In the spring of 1877 . . . on Middle Creek and its tributaries, and in various other places, I could see that the birds sensibly and radically diminished their numbers. One notable point was a few miles down Salt Creek from Lincoln. In May I visited the spot owing to the reported great numbers of locusts there. I estimated the number when I visited the place to be about 135 to a square foot. Already the birds had discovered it, and within sight were quail, larks, bobolinks, yellowheads (blackbirds), plovers, curlews, and a few prairie chickens. With my glass I could see them picking up these insects. In a month hardly a locust was left in this place."

A more recent occurrence of bird control of an orthopterous insect closely related to the Mormon cricket was recorded by A. C. Burrill. He stated: "The State of Washington with the aid of agents of the United States Department of Agriculture, has been attempting to control the Coulee cricket, which devastates large areas in the vicinity of Adrian, Washington. According to Mr. Max Reeher, scientific assistant in the United States Bureau of Entomology, western meadowlarks appeared in great numbers in the Dry Coulee last fall and began eating the newly hatched crickets. So efficient were these birds in controlling the situation that arrangements for a 1919 control campaign were abandoned. The meadowlarks were almost entirely responsible for the complete cleanup of the area."

Appraisal of the effect of birds on insect populations often has been done by computing the amount of food eaten by the individual bird and then prorating this for the number of birds involved. Such an approach was used in judging the worth of the lowly English sparrow in Utah at a time when the alfalfa weevil was rising to ascendancy as a pest of this forage crop.

To quote from my comments on observations made in 1910 and 1911 in the Salt Lake Valley: "Parent birds (English sparrows) were timed for a period, usually an hour, and at the end of this time the incoming bird was captured and the contents of its bill and throat recorded. By taking the average of a number of such observations a fair idea was obtained of the amount of food brought daily to a brood of these young birds. . . . From this series of observations it appeared . . . that 15 larvae (of the alfalfa weevil) or their equivalent in bulk of other insects was a fair estimate of the amount of food brought in at each trip by the adult birds. It frequently greatly exceeded this amount."

On the basis of this amount of food being brought in on each of 11 trips an hour and on the assumption that the young were fed 12 hours a day, a single brood of English sparrows would account for 1,980 larvae or their equivalent of other insect food. At that time it was not uncommon to find farmyards with straw-thatched cattle sheds, which supported 100 or more nests of English sparrows. Such a colony of birds would devour a daily total of 198,000 alfalfa weevil larvae or other insect food. As the young remained in the nest for at least 10 days, they would have eaten insect food equal to the volume of 1,980,000 weevil larvae during their nestling life. Inasmuch as these birds were feeding on the larvae of the alfalfa weevil to about one-fourth of their food, it would appear that they were accounting for about 500,000 larvae. And this activity was representative of what occurred on a number of farms.

Were it possible to restrict the insect eating of wild birds to particular areas and to compare the results with other areas not frequented by birds, appraisal of the benefits would not be so difficult. At times, however, circumstances make it possible to measure visually the effect of insect destruction by birds.

Such an opportunity arose in connection with the earlier study of the relation of bird life to the alfalfa weevil. In that case, however it was not a wild but a domestic species, the chicken, that yielded the information. It came about in the following manner. Farmers in the Salt Lake Valley early became aware of the beneficial work done by young chickens and turkeys through their feeding on weevil larvae. By placing brooder houses for these birds in or near badly infested fields, not only were the insects reduced but the birds in turn acquired a substantial amount of needed food. After cutting the first crop of hay in a field of 15 acres, one farmer near Kaysville, Utah, set out three colony houses containing 100 chicks that were 8 weeks old, 90 that were 5 weeks old, and 160 that were 2 weeks old. The broods were moved from place to place in the field as the areas about the houses were cleaned of larvae. On June 29, 1911, the field was inspected; in the areas where the brooder houses had been removed, the second crop had responded rapidly and was from 9 to 10 inches high. At other points, far from the feeding chicks, there was no evidence of the second crop. At one point, where two brooder houses had been located for some time at a distance of several rods apart, circles of bright green indicated the area over which the young birds had removed enough of the larvae to permit growth of the second crop. Were it possible to restrict the feeding activities of wild birds in a like manner I have no doubt but that the benefits of their work would be equally apparent.

Woodpeckers long have been recognized as archenemies of wood-boring insect pests, and much has been written of these defenders of our forest resources. It is difficult, however, to appraise with certainty the benefits of this type of work in large forest areas to which the birds have unrestricted access. Yet some significant appraisals have been made locally.

Tom T. Torrel, of the Bureau of Entomology and Plant Quarantine, had this to say regarding an infestation of Engelmann spruce beetles in the Kootenai National Forest in Idaho:

"In 1937 a severe infestation of the Engelmann spruce beetle was reported to be depleting stands of spruce in the Pinkham Creek drainage on the Kootenai National Forest. . . . During the time of the second examination in June 1938, rather large groups of infested spruce were found with overwintering brood. Woodpecker activity, however, had destroyed the brood to such an extent that the source of potential reinfestation was reduced to the protected brood below the snow line and it was predicted that very little reinfestation would occur."

Later comments on the same situation pointed out: "Woodpeckers had removed a large part of the bark from all trees above the snow line and it is believed that perhaps 75 to 80 percent, or even more, of the broods above snow line have been destroyed. We have observed that woodpeckers concentrate upon the most heavily infested trees, which allows the greatest returns for their labor. . . ."

More recent reports of the beneficial work of woodpeckers in the suppression of spruce beetles have come from the White River National Forest in Colorado, where field representatives of the Department of Agriculture were quick to detect evidence of the good work. C. L. Massey and Frank T. Hutchison were convinced that "during the summer of 1947, woodpeckers were the most important natural enemy of the Engelmann spruce beetle in the area." Three species of woodpeckers were involved; many of the heavily infested trees were completely stripped of bark; and in those instances the "mortality of the brood approaches 100 percent. Even a slight amount of woodpecker work reduced the beetle population by more than half." It is hoped that such observations on an insect pest that is threatening much of the stand of Engelmann spruce may be continued and the full story of the role of the woodpeckers recorded.

McAtee has given us a thorough summary of the recorded instances of caterpillar control by birds, and from it I select a few citations.

"The tussock moth caterpillar is generally supposed to be too hairy for birds, but this is another strained assumption. When they are common in Washington, D. C., nearly every robin seen carrying food to its young shows a telltale white fluff at the end of its bill. . . . Mr. Alan G. Dustan . . . in Canada . . . found that birds and ants are responsible for holding the insect at par in forests. When he exposed larvae to birds, the supply disappeared regularly and he credits birds with destroying half of the larvae hatching in forests. He further says that 'practically every egg mass laid above the snow line (and over 90 percent of them are) had been either partially or wholly destroyed by birds.' Cases of local extermination of tussock moths are recorded for the English sparrows in Massachusetts and the hairy woodpecker in Ohio."

McAtee goes on to report a case in which "starlings had locally extirpated a mixed infestation of brown-tail and gypsy moth larvae, and when E. H. Forbush was in charge of the gypsy-moth campaign for the State of Massachusetts, birds were observed to so hold the gypsy moth in check at one locality for several years that work by the State force was suspended. . . . It was almost impossible to complete certain experiments with larvae protected by netting bags because so many caterpillars were taken from the nets by birds. Sixty percent of the gypsy moth larvae used in these experiments were destroyed by birds."

The appleworm, larva of the codling moth, has also come in for attention by numerous birds. Even before the turn of the century, M. V. Slingerland at the Cornell Agricultural Experiment Station asserted that "by far the most effective aids to man in controlling the codling moth are the birds." This conclusion was reached by reason of the scarcity of intact hibernating cocoons and by the abundance of empty ones which apparently had been attacked by birds.

In New Hampshire, E. D. Sanderson reported: "Only 5 to 20 percent of the larvae survived the winter. An examination of seven trees . . . showed but 5 percent alive in the spring, 87 percent having been killed by birds, 4 percent by disease and 3 percent by cold. . . . It is quite evident that the birds, particularly the downy woodpeckers and nuthatches, are the most important enemies of the codling moth in New England. . . ."

And so the story continues. There are on record instances of commendable work by birds in the suppression of many other species of caterpillars, flies, beetles, ants, true bugs, plant-lice, and scale insects. Outstanding as these accomplishments are, they still may not represent the most important contribution by birds to man's battle against destructive insects. The cases I have cited, from the very nature of things, are conspicuous examples of the utility of birds; they are the high lights that have attracted attention. Their recital has been used to punctuate a story which may have its greatest significance, not in the spectacular, but in the day-by-day pressure exerted by birds. This effect is difficult if not impossible of measurement, yet nevertheless certain to be there.

Another consideration that has raised doubts in the minds of some who attempt to interpret the utility of birds is the realization that they feed not exclusively on insects injurious to man but (within certain limits) rather indiscriminately on whatever insects may be present and available to capture. Thus, both injurious and beneficial insects may be reduced.

An answer to that puzzling situation was well phrased by the late F. E. L. Beal in an article in the Yearbook of Agriculture for 1908: "Whoever expects to find in birds beneficent organisms working with a sole view to the benefit of the human race will be doomed to disappointment. Birds eat food to sustain life, and in their selection are guided entirely by considerations of their own. If all species of insectivorous birds be considered as a whole, it is found that they eat insects of the various species in about the proportions in which these species exist in nature. . . . It would appear that the true function of insectivorous birds is not so much to destroy this or that insect pest as it is to lessen the numbers of the insect tribe as a whole—to reduce to a lower level the great flood tide of insect life."

To that statement I add that flexibility of food habits and a tendency to prey on what is most abundant and easiest to capture make the bird world a highly mobile and responsive force for the reduction of any insect that may be inordinately abundant—significantly, the destructive insects are as a rule the most abundant ones.

One encounters fewer records of insect destruction by mammals than by birds—a reflection, no doubt, of conditions as they exist. As a group, mammals do not exert the pressure on insect life that birds do. That is true notwithstanding the fact that North American bats are largely if not exclusively insectivorous; that moles, shrews, and certain small rodents, particularly grasshopper mice, skunks, and the armadillo, feed extensively on insects; and that many other species partake of insects frequently. Availability and abundance play an important part in determining the extent of insect destruction by the casual feeders on insects among mammals. Those same considerations, however, often determine the abundance or even survival of bats, shrews, moles, and the armadillo, which are highly dependent on arthropod food.

Relatively little is known statistically of the over-all or even local effect of mammalian predation on insects. The feeding of highly insectivorous bats is essentially indiscriminate in character. That I must stress despite the frequently proclaimed (yet unproved) prowess of these winged mammals in mosquito control. No doubt many a mosquito falls as prey to these nocturnal aviators, but a few moments spent in observing their flight maneuvers will convince one that moths, beetles, ephemerids, and other high-flying forms are more likely to be caught than the low-flying mosquitoes. Stomach examination likewise has demonstrated this fact.

Shrews and moles feed to a large extent on subterranean invertebrates, among which are the larval and pupal forms of numerous destructive beetles and lepidopterans. Earthworms, because of their abundance, also are a staple item of food. Mice of various kinds, particularly grasshopper mice and deer mice, eat many insects. They were conspicuous in their destruction of the range caterpillars in New Mexico in 1913. That insect appeared in nearly half of 56 stomachs of deer mice collected on open range lands and, in bulk, they formed nearly a fifth of the food. Grasshopper mice collected under the same conditions indicated an even better performance, for, besides the consumption of an equal portion of range caterpillars, they had consumed even larger quantities of grasshoppers; the only vegetable food they had eaten were the seeds of Russian-thistle.

Skunks also rendered yeoman service against the range caterpillar in New Mexico at that time. On the basis of examined droppings, fully 85 percent of their food was comprised of the pupae of this insect. Late in the pupal season, the localities that showed signs of the presence of skunks would be largely free of pupae. Frequently areas of 4 to 5 acres would have two-thirds of the silken cocoon webs empty. In a section near Maxwell it was reported that only 5 percent of the pupae remained undamaged. This, no doubt, was the result of attacks by mammals, including several species of mice, skunks, badgers, and even coyotes.

Without doubt the nine-banded armadillo present in considerable numbers in Texas, Louisiana, and Florida is our most insectivorous medium-sized mammal. Stomach examination has revealed that more than 92 percent of its food is insects and other invertebrates, a performance that places it closely behind the bats in its relation to insects. In volume of food consumed, it greatly exceeds the latter; in diversity of items eaten, the armadillo probably has no peer among mammals. One specimen, found near Ingram, Tex., had ingested at least 87 different food items (mainly insects) aggregating more than 3,100 individuals.

Among the armadillo's insect food are numerous outstanding agricultural pests. Nearly 28 percent of the diet consists of the adults and larvae (white grubs) of scarab beetles. Termites, ants, and caterpillars (cutworms) constitute appreciable portions, and earthworms, millipedes, and crawfishes round out a regimen that is distinctly subterranean in origin. The location of the armadillo's food—beneath the surface—tends to offset somewhat the benefits derived from its consumption. In its energetic search for subsurface food, the 'dillo pays little concern for the welfare of young plants. The result is that sprouting corn may be destroyed immediately by the armadillo in its removal of wireworms, which may kill the plant at a later time. In general, however, the character of the armadillo's food indicates an influence for good.

In approaching the subject of birds and mammals in relation to insects, one naturally thinks in terms of direct predation, the effect wrought on insect populations by reason of the food habits of the predators. That process of reasoning has prevailed ever since serious consideration has been given to the three-cornered relationship between man and injurious insects at opposing points and those natural factors that tend to lessen the intensity of this struggle. Research aimed at demonstrating and recording the effect of such predation has characterized the sciences of economic ornithology and mammalogy in this country and in Europe for more than a century.

As early as 1858 J. W. P. Jenks was examining the stomachs of robins in Massachusetts to learn something of their food habits and economic relations to agriculture, and, on the basis of that work, he may be considered the American pioneer in that method of research. Some 20 years later, Professor Aughey of Nebraska published his *Notes on the Nature of the Food of the Birds of Nebraska,* based on studies over a period of 13 years on 90 different species and on an examination of more than 630 stomachs. Then followed the work of S. A. Forbes in Illinois, F. H. King in Wisconsin, B. H. Warren in Pennsylvania, and C. M. Weed in New Hampshire. Others, many of whom were entomologists, contributed to the early knowledge of the relation of birds to insects and their control. All of this served to create an early and growing appreciation in State and Federal legislative halls of the significance of biological control and led directly, in the 1880's, to the enactment of Federal legislation implementing such studies. The first appropriation ($5,000) authorized specifically for such research was allocated in 1885 to the entomologist of the Department of Agriculture, who had "declared that the interrelation of birds and insects was a subject which he long had desired to make a part of the work of his division," and stated that the food-habits phase of the work was of chief interest to the farmer.

It is particularly significant that, although the stimulus for this early effort to determine the economic status of birds in the United States came from the American Ornithologists Union, it had the aggressive support of entomologists who long had recognized, probably more clearly than any other group, the importance of natural enemies in the control of insect pests. From that modest beginning the science of economic ornithology and mammalogy in the United States grew rather steadily during the following three decades. McAtee, who rightfully may be considered the dean of American economic ornithologists, in 1913 published an index of papers dealing with the food and economic relations of birds prepared by members of the Biological Survey, the predecessor of the Fish and Wildlife Service. The report, published by the Department of Agriculture, involved 131 documents discussing 401 native and 59 foreign or introduced birds. Between that date and 1933 (the point of last summarization), 84 additional species of birds were formally reported upon and others mentioned in briefer statements. Since 1933 there has been less study of food preferences revealed through stomach analysis and greater emphasis placed on field appraisal. Nevertheless, the desirability and necessity of stomach examination will remain as long as wildlife administration is to be based on facts.

Although the study of the economics of birds and mammals in the United States has been more extensive than that carried out in Europe, the science has not been neglected there and its history is even older. The names and writings of Prevost in France, Schleh and Rörig in Germany, and Gilmour and Collinge in Great Britain attest to the wide recognition given in Europe to the importance of the vertebrate controllers of insect pests. Of utmost significance is the work conducted abroad on species later introduced to this country, notably the English sparrow and the starling.

In 1883 Schleh published on the food of the house sparrow in Germany and, although he did not use the volumetric method of computing food in vogue today, the results he obtained compare favorably with current procedures. More recently, Walter E. Collinge in England has given us an appraisal of the English sparrow in that country and direct comparisons can thereby be made of a species which, in the one case, has been with us for about a century with the same bird in an environment where it has existed for many centuries. Further comparisons of the economics of the English or house sparrow also are available from Turkestan, where D. Kashkarov and others appraised its direct influence on the production of grain and other crops.

Even a more precise comparison of the economics of an introduced species according to its performances here and abroad is available by reason of the studies carried out in England and in this country on the starling, which was brought to this country late in the last century and now is generally abundant in the Eastern States and found in limited numbers on the Pacific coast. A comparison of the data obtained in these two studies left "not a shadow of doubt as to the marked economic superiority of the American bird based on a study of food habits at this time."

One might continue with such recitals at length and give citations of notable research carried out in economic ornithology in Europe, North America, South Africa, Australia, and elsewhere. All point to the fact that recognition of the influence of birdlife on the affairs of man is world-wide.

As one delves through the literature on the subject, he is impressed also by the fact that recognition of insect destruction by birds has come more frequently from the entomologists directly concerned with matters of insect suppression than from the ornithologists whose interest in the welfare of birds might at times bias deductions. In fact, the entomologists, confronted as they are with the problem of seeking every possible means toward achieving pest insect control, have ample reason for recognizing biological help from whatever source it may stem.

Much remains to be learned regarding the influence of birds and mammals on insect populations. Quantitative information, local, widespread, and current, of the effect of vertebrate predation on economically important insect pests is needed. Much of this will have to be acquired through intensive field observations and appraisal. Estimates need to be made on a substantial and representative scale of insect populations in the presence and the absence of vertebrate enemies; from them tangible data should be forthcoming on the present-day economics of such predation on the insect world.

In the meantime, it behooves us to retain and encourage to the utmost all of those natural elements whose suppressive effect on insect pests, be it great or small, is so sorely needed.

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